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Trace minerals and its role on reproductive performance of farm animals

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Abstract
Reproduction is the important productive parameter which affects the profitability of dairy industry. Micro minerals play an important role in animal’s reproductive physiology and its imbalance causes various problems leading to lowered reproductive efficiency. Therefore, adequate trace minerals supplementation and its absorption are required for various metabolic functions including reproduction and growth. Often correcting an imbalance in mineral levels may improve the reproductive performance, fertility and health of the animals. This article generally focused on the effect of various trace minerals on reproductive efficiency of farm animals.

Keywords: Farm animals, reproduction, trace minerals

1. Introduction

Minerals play an important role not only in structural components of animal body but also have a significant role in activities of an enzyme, hormone, as constituents of body fluids and tissues and also as regulators of cell replication and differentiation. The Deficiencies of minerals, its imbalances and toxicity may cause reproductive disorders in animals because minerals play an important role in health, production and reproduction performance of the livestock [1].The minerals are major nutrients required after energy and protein and should be given priority in order to optimize reproduction in dairy cattle [2].

As per their requirement, minerals are divided in two main groups i.e. macro minerals and micro minerals. The macro minerals which required in more than 100 ppm in diet and these are calcium, phosphorus, magnesium, potassium, sulphur, sodium and chloride. The second group is trace or micro minerals such as cobalt, copper, iodine, iron, manganese, selenium and zinc which are required in less than 100 ppm in the diet of animals. Generally the animals obtain minerals through the consumption of natural feeds, fodders and supplementation of inorganic salts in the ration. Micronutrients are involved in various functions like as intracellular detoxification of free radicals, synthesis of reproductive steroids and hormones. It also has a great role in the metabolism of carbohydrate, protein and nucleic acid. Mineral deficiencies or excesses may impair spermatogenesis, libido in the male fertility, embryonic development, survival rate, post-partum recovery activities, milk production and offspring development and survival.

Subclinical or marginal mineral deficiencies may be a larger problem than an acute mineral deficiency in animals because specific clinical symptoms are not evident to allow the producer to recognize the deficiency. However, animals continue to grow and reproduce but at a reduced rate. The trace mineral also declines immunity status in farm animal.

The trace elements serve as structural components of metalloenzymes in the body system. In adequate trace mineral levels leads to lose the enzyme activity. There are various metalloenzymes that are required for a wide range of metabolic activities like energy production, protein digestion, cell replication, antioxidant activity and wound healing. Minerals also play regulatory functions like zinc helps to influence transcription, Iodine serving as a constituent of thyroxin, a hormone associated with in thyroid function and energy metabolism.

2. Zinc (Zn)

Zinc is an essential component of over 200 enzyme systems which involved in the metabolism of carbohydrate, protein and nucleic acid, epithelial tissue integrity, cell repair and division, vitamin A and E transport and their utilization. In addition, Zn plays a major role in the immune system and certain reproductive hormones. Zn has a critical role in the repair and maintenance of the uterine lining following parturition, speeding return to normal reproductive function and oestrus. In bulls, a Zn deficiency results in poor semen quality and reduced testicular size and libido [3]. Zn has also been shown to increase plasma β-carotene level which is correlated to improvement in conception rates and embryonic development [4]. A good Zn status also improves fertility by reducing lameness, cows more willing to show sign of heat and improved mobility and performance of bulls. A severe Zn deficiency in cattle results in slow growth reduced feed intake, loss of hair, skin lesions that are most severe on legs, neck, head and around the nostrils, excessive salivation, swollen feed with open scaly lesions, and impaired reproduction [5]. A deficiency of Zn in males reduces testicular development and sperm production. Zn deficiency has been observed in ruminants fed on deficient feedstuffs. The recommended dietary content of Zn for dairy cattle stands between 18 and 73 ppm depending upon the stage of the lifecycle and dry matter intake. Cu, Cd, Ca and Fe reduce Zn absorption and interfere to its metabolism [6]. The requirement of Zn in the diet of dairy cows is near about 40 ppm [7]. The Zn supplementation study as $ZnSO4$ and Zn propionate in the diet of crossbred cattle, bulls reported improved semen quality in terms of quantitative and qualitative characteristics of semen and organic form of Zn (Zn propionate) showed a better response in improving sperm per ejaculate, mass motility and semen fertility test like bovine cervical mucus penetration [8].

3. Copper (Cu)

Copper is animportant component of number of a enzymes including superoxide dismutase, ceruloplasmin, lysyl oxidase and thioloxidase. The action of these enzymes is to scavenge free radicals and thus prevent tissue susceptibility to infections, increase structural strength of connective tissues and blood vessels, increase strength of the horn and hooves. It also plays an important role in the immune system. Cu and Zn have a significant correlation with reproductive hormones (progesterone and estradiol) [9]. Cu deficiency in cattle is generally due to the presence of dietary antagonists, such as S, Mo and Fe that reduce Cu bioavailability. Deficiencies of Cu also associated with retained placenta, embryonic death and decreased conception rates and anoestrous [10]. It has been observed that dairy cows with higher serum Cu levels take less days for first service, fewer services per conception and fewer days to open. Proper copper supplementation of the sire is needed for production of quality semen. Feeding a total of 10 to 15 ppm copper in the ration dry matter or supplementing with 10 ppm copper should meet dairy cattle needs. If rations contain antagonists such as elevated Fe, S, or Mo, replacing 35 percent of supplemental copper with organic copper sources improved Cu availability. The following mineral ratios may be helpful in maintaining Cu levels in blood: Zn: Cu 4:1, Cu: Mo 6:1 and Fe: Cu 40:1. Amino acid chelates of Cu, Mn and Zn have been reported to reduce services per conception significantly in dairy cows.

4. Selenium (Se)

The safety margin (difference between normal requirement and toxic dose) for Se is so narrow, its deficiency is less common in livestock than its toxicity, but responsible for weak, silent or irregular oestrus cycle, retained placenta, early embryonic death in foetus, still birth or weak offspring and abortions in dairy animals [11]. It is also responsible for reduced sperm mortality in male animals. It is also observed that improvement in the conception rate at first service due to the supplementation of Se [12]. It has been also reported that due to Se deficiency animals are more prone for the incidence of retained placenta, cystic ovaries, mastitis and metritis which can be reduced by supplementation of selenium [13]. In some areas of our country soils are deficient in Se. Dairy producers have begun to rely more heavily on home grown grains and forages and less on purchased feeds, so that's why the need for Se supplementation has been recognized. Se deficiency also has been related to abortions, a high incidence of embryonic fetal mortality, poor fertility in females, and increased incidence of metritis, a higher level of systemic infection and the birth of dead or weak claves in herds. Blood Se levels in these herds generally been extremely lower level (<5mg/100 mL). Feedstuffs should contain at least 0.1ppm Se on a dry matter basis. In some other herds, feed sources must be supplemented with Se injections to maintain blood levels above there commended 8-10 mg/100ml. In herds where Se levels are extremely low, injections are often required to maintained blood Se levels to normal. After Se injection, feed supplements may provide enough Se to maintain adequate blood levels in the dairy cow. Blood tests are recommended to confirm Se status in animals. Se plays normal spermatogenesis in male and is an essential component of a range of selenoproteins, including glutathione peroxidase, thioredoxinreductase and iodothyroninedeiodinase. It also plays a vital role in protecting both intra and extracellular lipid membranes against oxidative damage and protects milk lipids from oxidation [14]. Both deficiency and excess Se have been reported to be detrimental to normal spermatogenesis process [15]. The dietary requirement of Se for most of the species is near about 0.1 ppm, but the revised requirement of Se for better immune response in dairy animals is 0.3 ppm [16]. Basically two major sources of Se are naturally originating Se which is obtained from plants, in the form of Seleno-amino acids, including selenomethionine and selenocysteine, and second source isthe inorganic Se in the form of selenate or selenite. Selenized yeast isone of the most bioavailable source of Se as compared to Se selenite [17].

5. Manganese (Mn)

Manganese is an indispensable mineral for dairy animals like other minerals. There is large variation in Mn levels in feed and fodder. Fodders arerich source of Mn but concentrate ingredients may be deficient [18]. Generally, legume and grass hays have more Mn than corn or corn silage and Mn is reported to be more available in hay than silage [13]. Mn is an activator of enzyme systems in the metabolism of carbohydrate, fats, protein and nucleic acids. Mn also has a vital role in reproduction, cholesterol synthesis [19]. Mn also required for synthesis of the steroids, estrogen, progesterone and testosterone. Insufficient steroid production results in decreased circulating concentrations of these reproductive hormones resulting in abnormal sperm in males and irregular estrus cycles in female's Corpus luteum may also be influenced by Mn deficiency. Concentration of Mn in vagina is higher in cycling animals than in anoestrous animals. A deficiency of Mn may be associated with suppression of estrus, cyclic ovaries and reduced conception rate [6]. The requirements of Mn are for maintenance, growth, pregnancy and for lactation are about 0.002 mg/kg of body weight (1.2 mg/day for an average Holstein cow) 0.7 mg/kg of growth, 0.3 mg/d and 0.03 mg/kg of milk respectively [7]. Gestating cattle may need up to 50 mg of Mn/Kg of DM because it helps in skeletal cartilage and bone formation of fetus [20]. This value is higher than 40 mg of Mn/Kg of DM recommended by [21].

6. Cobalt

Occurrence of Infertility as secondary consequences of debility conditions due to severe Co deprivations through reduced general metabolism. This deprivation also leads to delay in onset of puberty, uterine involution and decrease inconception rate [22]. Co deficiency is associated with an increased incidence of silent heats, a delayed onset of puberty, non-functional ovaries and abortion. Inadequate Co levels in the diet have been correlated with increased early calf mortality. In ruminants there is need of Co to meet the vitamin B requirements of both the ruminal bacteria and the host animal because Vitamin B is a water soluble vitamin which is produced by rumen microbes. The depletion of Co andvitamin Bat parturition through colostrums causes depressed milk production, colostrum yield and quality [6]. Early lactation cows have a reduced vitamin B status due to increased demands of lactation [23]. Mn, Zn, I and monensin may reducecobalt deficiency. The recommendation for cobalt requirement in dairy cows varies between 0.10 mg/kg DM [7] and 0.20 mg/kg DM [24]. Co supplementation up to 50 mg daily in Holstein cow have been reported to improve feed digestion in heat stress depression in feed digestibility, fat yield and milk yield [25]. Recent studies reported that oral Co acetate administration to lactating cows and ewes decreased milk concentrations of fatty acids containing a cis-9 double bond, and inhibition of stearoyl-coenzyme A desaturase activity [26], thus it play an important role in mammary lipogenesis in ruminants and responsible for the majority of cis-9, trans-11 conjugated linoleic acid and a significant amount of cis-9 18:1 which are secreted in bovine [27].

7. Iodine (I)

Iodine is important in the development of fetus and maintenance of general basalmetabolic rate. I is an essential trace element for dairy animals. I is incorporated into the thyroid hormones, which have multiple functions as cell activity regulators. I requirement is important in the development of foetus and maintenance of general basal metabolic rate by synthesis of thyroid hormone. Signs of I deficiency include delay in puberty, suppressed or irregular oestrus [13], failure of fertilization, early embryonic death, still birth with weak calves, abortion and increased frequency of retained placenta in females, decrease in libido and deterioration of semen quality in males [22]. I deficiency affects reproductive capacity, brain development and progeny as well as growth. Iodine deficiency leads to delay in puberty and irregular estrus [13], failure of fertilization, early embryonic death, still birth with weak calves, abortion, and increased frequency of retained placenta in females and decrease in libido and deterioration of semen quality in males is also caused by iodine deficiency [22]. I supplementation recommended for cows consume 15-20 mg of iodine each day. Recently, the effects of excessive I intakes have been recognized. Excessive iodine intakes have been associated with various health problems including abortion and decreased resistance to infection anddisease. Recently, The Signs of subclinical iodine deficiency in breeding females include suppressed oestrus, abortions, still births, increase in frequency of retained placentas and extended gestation periods [28]. The number of studies have reported beneficial effects of lugol's iodine in the treatment of silent oestrus, repeat breeding and conception rate [29].

8. Conclusion

To improve the productive performance in domestic animals it is necessary to provide essential nutrients in a diet. Mineral provided in appropriate quantity and in that form which is most biologically useful. Mainly trace mineral is effect in reproduction of dairy animals which are generally found within the trace element group.Ca and P are mainly playing important role in fertility of animal.

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